WHAT IS CLAIMED IS:

1. A tunable optical add-drop multiplexer (OADM) based on an SOI (silicon-on-insulator) wafer, comprising:

a multimode interference region;

at least a grating formed on said multimode interference region; and

at least two electrodes formed on two sides of said multimode interference region and having carriers induced thereinto,

thereby a variation of an optical waveguide in said grating is controlled through controlling said carriers induced into said electrodes so as to further control different propagation of wavelength signals.

2. The optical add-drop multiplexer according to claim 1 further comprising at least an input port formed on one of said two sides of said multimode interference region for receiving multiple wavelength signals

3. The optical add-drop multiplexer according to claim 1 further comprising at least a drop port formed on one of said two sides of said multimode interference region for gathering a portion of said wavelength signals.

4. The optical add-drop multiplexer according to claim 3 further comprising at least an add port formed on the other said side of said multimode interference region for adding at least a signal having a random wavelength.

5. The optical add-drop multiplexer according to claim 4 further comprising at least an output port formed on the other said side of said multimode interference region for outputting a non-gathered portion of said wavelength signals and said signal having a random wavelength.

6. The optical add-drop multiplexer according to claim 1 wherein said grating is a Bragg grating.

7. The optical add-drop multiplexer according to claim 1 wherein said grating varies a refractive index thereof so that an wavelength signal passing therethrough has a tunable wavelength due to an involved said index.

8. The optical add-drop multiplexer according to claim 1 wherein said grating is structurally changed through arranging identical grating periods so as to control a wavelength response.

9. The optical add-drop multiplexer according to claim 1 wherein said grating is structurally changed through arranging different grating periods so as to control a wavelength response.

10. The optical add-drop multiplexer according to claim 1 wherein said grating is changed in wavelength response through altering a height thereof so as to add or drop different said wavelength signals.

11. The optical add-drop multiplexer according to claim 1 wherein said multimode interference region has a variable cross section so that a variation of a corresponding gathered wavelength is presented after said carriers are controlled by different voltages.

12. The optical add-drop multiplexer according to claim 1 wherein said multimode interference region has a tunable length and a tunable width for adjusting a wavelength response of the interference so as to adjust a position of an initial central wavelength.

13. The optical add-drop multiplexer according to claim 1 wherein said electrodes are changed in structure and/or in dimension so that a current of said carriers has a different injecting efficiency into said electrodes so as to control a speed of adding and dropping a wavelength.

14. The optical add-drop multiplexer according to claim 1 wherein said electrodes are electroplated by different materials so that a current of said

carriers has a different injecting efficiency into said electrodes, and thereby a power variation of a corresponding gathered wavelength is controlled by a variation of a refractive index of said grating so as to design different central wavelength responses.

15. The optical add-drop multiplexer according to claim 1 wherein an instantaneous variation of an index of said grating is achieved through instantaneously inputting different voltages for controlling a power variation of a corresponding gathered wavelength so as to achieve an instantaneous exchange of wavelengths.

16. The optical add-drop multiplexer according to claim 1 wherein a gathering of said wavelength signals is controlled through operating different instantaneous voltages.

17. The optical add-drop multiplexer according to claim 1 wherein said electrodes are sectionalized and supplied by different voltages for simultaneously gathering different wavelength signals.

18. The optical add-drop multiplexer according to claim 1 wherein when a number of both said output and input ports are N, an optical wavelength exchanging switch with N x N ports is obtained through a serial connection thereamong by using a module arrangement, and, through being supplied different voltages and having multi-sectional electrodes, said optical wavelength exchanging switch simultaneously gathers different wavelength signals.

19. The optical add-drop multiplexer according to claim 1 wherein plural 2 x 2 said wavelength tunable optical add-drop multiplexers based on said SOI wafer are combined to make an N x N Benes optical switch.

20. The optical add-drop multiplexer according to claim 1 wherein 2 x 2

said wavelength tunable optical add-drop multiplexers based on said SOI wafer are combined in a multilayered sub-matrix arrangement so as to make an N x N MDB switch.

21. A method for manufacturing a wavelength tunable optical add-drop multiplexer based on a semiconductor wafer, comprising steps of:

(a) providing a substrate;

(b) forming an insulating layer and a conducting layer on said substrate;

(c) defining a multimode interference region and plural input/output waveguides on said conducting layer;

(d) forming an N type region and a P type region respectively on two sides of said multimode interference region;

(e) defining a periodic grating structure on said multimode interference region; and

(f) forming two electrodes respectively on said N type region and said P type region.

22. The method according to claim 21 wherein said semiconductor wafer is an SOI (silicon-on-insulator) wafer.

23. The method according to claim 21 wherein said substrate is a silicon substrate.

24. The method according to claim 21 wherein said insulating layer is a silicon dioxide layer.

25. The method according to claim 21 wherein said conducting layer is a polysilicon propagating layer.

26. The method according to claim 21 further comprising a step of doping a doping layer between said insulating layer and said conducting layer.

27. The method according to claim 21 wherein said step (c) is performed by

a reactive ion etching.

28. The method according to claim 21 wherein said N type region is formed by doping a pentad element into said conducting layer through an ion implantation.

29. The method according to claim 28 wherein a refractive index of said grating is variable through a different concentration distribution of the ions doped by said ion implantation so as to control a variation of a corresponding gathered central wavelength of said wavelength tunable optical add-drop multiplexer for achieving a design of different central wavelengths.

30. The method according to claim 29 wherein said ions are controlled by a current supplied thereto for obtaining different refractive indices of said grating so as to control a power variation of a corresponding gathered wavelength of said wavelength tunable optical add-drop multiplexer for achieving a wavelength exchange.

31. The method according to claim 21 wherein said P type region is formed by doping a trivalent element into said conducting layer through an ion implantation.

32. The method according to claim 31 wherein a refractive index of said grating is variable through a different concentration distribution of the ions doped by said ion implantation so as to control a variation of a corresponding gathered central wavelength of said wavelength tunable optical add-drop multiplexer for achieving a design of different central wavelengths.

33. The method according to claim 32 wherein said ions are controlled by a current supplied thereto for obtaining different refractive indices of said grating so as to control a power variation of a corresponding gathered wavelength of said wavelength tunable optical add-drop multiplexer for

achieving a wavelength exchange.

34. The method according to claim 21 wherein said step (e) is performed by an electron beam etching.

35. The method according to claim 21 wherein said electrodes are formed through electroplating a metal thin film on said N type and said P type regions.